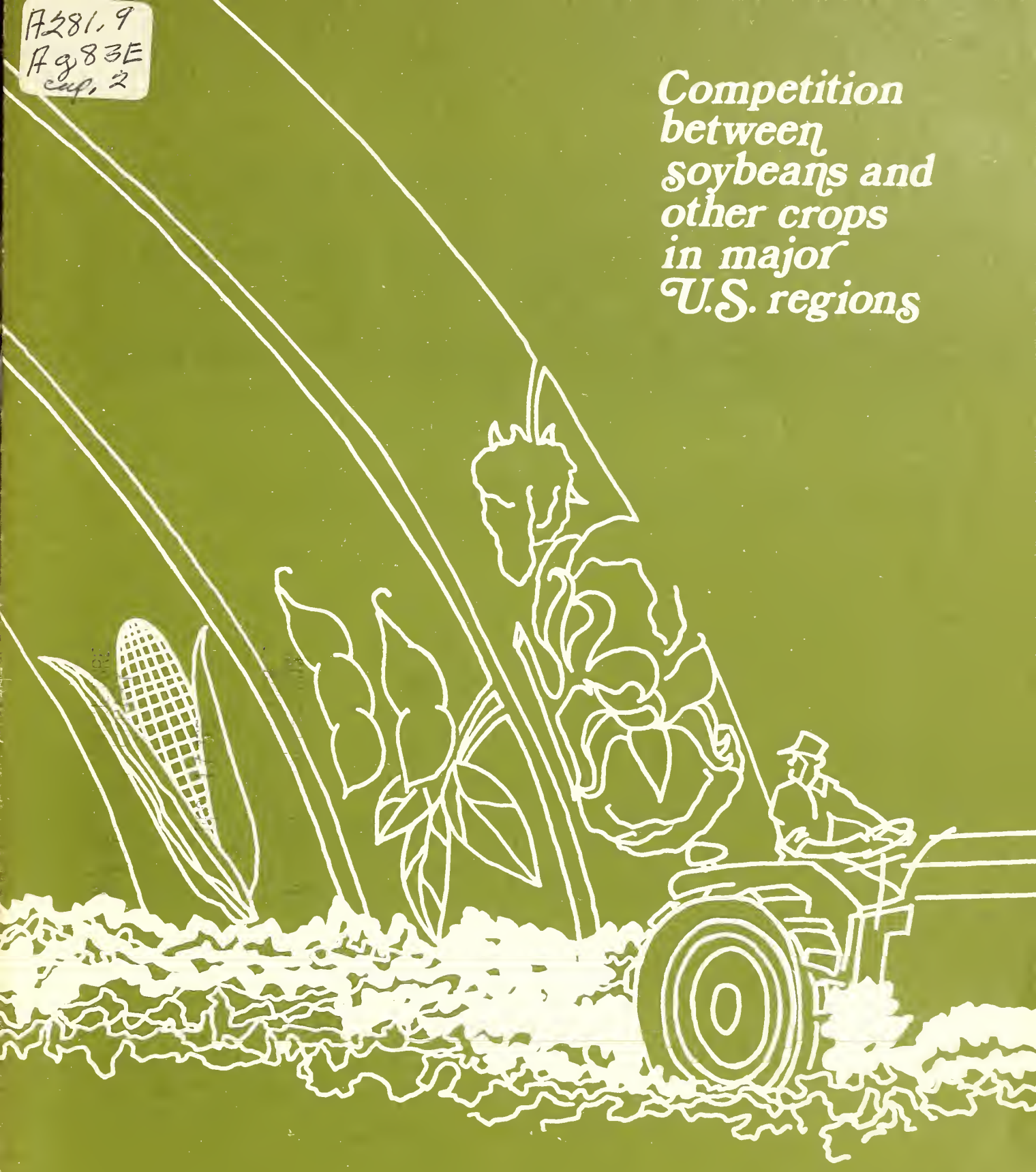
Competition between soybeans and other crops in major U.S. regions



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COMPETITION BETWEEN SOYBEANS AND OTHER CROPS IN MAJOR U.S. REGIONS. By W. A. Boutwell, H. M. Harris, and D. Kenyon. Economic Research Service, U.S. Department of Agriculture. ERS-588.

ABSTRACT

Price relationships between soybeans and corn and between soybeans and cotton representing equal returns per acre are presented. In the spring of 1974 price and cost levels shifted the competitive advantage to corn and cotton relative to soybeans. Iso-returns curves were used to establish break-even price ratios and to provide an easy method for adjusting them under changing conditions.

Key words: Soybeans, corn, cotton, cottonseed, price ratios, iso-returns curves, production costs.

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PREFACE

Production costs, yields, and price levels interact to determine the break-even ratios between alternative crops. Recent changes, primarily in costs and prices, have made it necessary to reevaluate the soybean/corn and soybean/cotton ratios. These ratios, calculated for the 1974 planting season, favored corn and cotton over beans. As a result, farmers planted fewer acres to soybeans and more to corn and cotton.

Rapidly changing costs and prices will necessitate continuous analysis of ratios. This report is intended to aid production and policy decisionmakers evaluate the competition among soybeans, corn, and cotton in the current dynamic atmosphere.

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SUMMARY

Soybeans were at a relative disadvantage to the major competing crop in each of the three major soybean-producing regions during the 1974 planting season. Although soybean prices were strong in each case, the major alternative crop was in a more favorable price/returns position. In addition, both corn and cotton at prices available for contracting and hedging in early 1974 were in a more favorable returns position than soybeans.

The ratios between soybean prices and competing crop prices representing equal returns per acre are not constant. The particular ratio value depends not only on yields and costs, but also on prices. Variability due to price levels was analyzed for corn and soybeans using average costs and yields in both the Corn Belt and South Atlantic regions. The ratios were higher at higher price levels and asymptotically approached a maximum. This maximum varies depending on the costs and yield, resulting in a difference between producing regions. The maximum was lower for the South Atlantic than for the Corn Belt, explaining why producers in these regions react differently under what appear to be similar conditions.

COMPETITION BETWEEN SOYBEANS

AND OTHER CROPS IN MAJOR U.S. REGIONS

By

W. A. Boutwell, H. M. Harris, and D. Kenyon[1]

INTRODUCTION

Each year farmers must choose from among the various agricultural endeavors open to them. These decisions are based primarily on the individual's anticipated prices, costs, and yields of the alternative enterprises. Production decisions are constrained by the fixed complement of resources available. However, flexibility exists to the extent that the fixed resources can be substituted for one another or used more intensively for a particular enterprise.

Rules of thumb are often applied by farmers making production decisions. Examples include statements about profitable levels for the hog/corn and milk/feed price ratios. Another commonly used ratio is the soybean/corn price ratio. A rule of thumb often states that the break-even price ratio between soybeans and corn is 2.5 to 1. This is, at a ratio of 2.5:1, anticipated net returns would be the same for corn and soybeans. Economists have also relied on this ratio to anticipate likely adjustments in plantings. For instance, George Kromer, in presenting the outlook for oilseed at the National Outlook Conference in December 1973, pointed out that the then-existing ratio of 2.3:1 was favorable to increased corn production at the expense of soybeans.

A rule of thumb such as the break-even ratio can be an invaluable decision-making aid. However, it changes as prices, costs, and yields change, making continuous evaluation necessary. This publication presents a simple technique for evaluating the profitability of planting soybeans or a competing crop, given anticipated prices, costs, and yields--that is, for recalculating the thumb rule value as conditions change. The technique can also help the analyst or policy-maker predict likely adjustments in response to changing conditions.

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MAJOR PRODUCING REGIONS

Break-even prices were computed for soybeans and their major competitor for resources in the three major soybean-producing regions--the Corn Belt, Delta, and South Atlantic. The Corn Belt includes Iowa, Indiana, Illinois, Ohio, Missouri, and Minnesota. The Delta is composed of Mississippi, Louisiana, Arkansas, and Tennessee. The South Atlantic region consists of Virginia, North Carolina, South Carolina, Georgia, and Alabama. These three areas have historically accounted for most of the soybeans produced in the United States. In 1973, they produced 88 percent of the U.S. total (table 1).

The Corn Belt produces more soybeans than any other region. In 1973, this six-State area harvested 34 million of the Nation's 56.4 million soybean acres. Harvested acreage more than doubled in this region during the last decade, as new lands were brought into production and soybeans competed successfully with alternative crops for existing acreage. The feed grain program also contributed significantly to expanding soybean acreage by limiting acreage on such major crops as corn and wheat. Currently, however, the program calls for no restrictions and soybeans must compete without the assistance of feed grain acreage restrictions.

Corn is the major crop produced in the Corn Belt and the primary competitor of soybeans. Corn production expanded significantly over the last decade, from 2.6 billion bushels in 1960 to 3.9 billion bushels in 1973. However, unlike soybean acreage, corn acreage fell 14 percent during the period to 37.2 million acres. Increased production thus reflects an increase in yield, from 63 to 100 bushels per acre. Larger yields have freed acreage for other crops, primarily soybeans, but at the same time have strengthened corn's competitive position. Smaller increases in soybean yields relative to corn during this period meant that soybean prices had to increase relative to corn to maintain a competitive level of returns per acre. However, by 1974, higher fertilizer prices partially offset the effect of historical trend in corn yield.

Corn is also the major competitor of soybeans in the South Atlantic region. Although neither corn nor soybeans in the area comprises a large percentage of total U.S. production, both are important in the region's agricultural sector. In 1973, slightly over 4 million acres each of corn and soybeans were harvested in this region. With 1973 regional farm prices averaging $2.85 per bushel for corn and $6.04 for soybeans, these two crops contributed about $1.3 billion of gross revenue to the region.

The decisionmaking process is the same for farmers in the South Atlantic region as for those in the Corn Belt. However, costs and yields differ, altering the relative competitive position between corn and soybeans from that of the Corn Belt.

Cotton is the major income-producing crop in the Delta. Soils suitable for cotton production are also suitable for soybean production. Soybean acreage has expanded rapidly in the Delta, increasing from about 4 million acres in 1960 to over 10 million in 1973. This increase partially reflects the cotton program which restricted acreage. However, it also reflects the increase in soybeans' competitive position relative to cotton and other alternative crops in the region.

Table 1--Acreage harvested and yield per harvested acre for corn, soybeans, and cotton, selected regions, 1960-73

Year	Corn Belt[1]				Delta[2]				South Atlantic[3]				Total U.S. harvest		
	Corn		Soybeans		Cotton			Soybeans	Corn		Soybeans				
	Acres harvested	Yield	Acres harvested	Yield	Acres harvested	Lint yield	Cotton-seed yield	Acres harvested	Yield	Acres harvested	Yield	Acres harvested	Yield	Corn	Cotton	Soybeans
	1,000 acres	Bu. per acre	1,000 acres	Bu. per acre	1,000 pounds	100 pounds	Pounds	1,000 acres	Bu. per acre	1,000 acres	Bu. per acre	1,000 acres	Bu. per acre	--1,000 acres--		
1960	40,572	63.0	15,920	24.4	3,862	49.3	844	3,968	22.3	4,935	39.3	1,425	21.0	71,422	15,309	23,655
1961	32,414	73.3	18,271	27.0	4,013	49.2	851	4,357	20.4	4,190	41.8	1,568	20.9	57,634	15,634	27,003
1962	32,082	75.5	18,377	25.9	4,043	50.4	862	4,637	21.1	3,785	43.5	1,601	20.8	55,726	15,569	27,608
1963	34,988	79.2	18,569	27.4	3,691	64.5	1,083	5,329	18.5	3,831	46.3	1,678	18.8	59,227	14,212	28,615
1964	33,881	71.7	20,075	24.2	3,724	65.3	1,111	5,651	20.1	3,741	48.4	1,848	21.8	55,369	14,057	30,793
1965	34,686	83.1	22,003	26.0	3,632	61.5	1,047	6,365	22.0	3,613	59.5	2,136	22.3	55,392	13,615	34,449
1966	36,044	81.6	22,568	26.8	2,580	54.2	944	7,267	23.3	3,583	44.0	2,458	22.7	57,002	9,552	36,546
1967	38,427	101.1	23,398	25.5	2,171	46.9	848	8,610	24.8	3,904	66.7	3,046	23.5	60,694	7,997	39,805
1968	34,989	88.6	24,690	29.8	2,855	57.4	1,013	8,986	23.4	3,787	51.7	2,754	15.8	55,980	10,160	41,391
1969	33,362	95.1	24,116	30.7	3,060	52.7	884	9,668	21.0	3,738	53.0	2,646	24.6	54,574	11,055	41,337
1970	35,338	78.5	24,803	29.7	3,100	55.6	913	9,818	22.8	3,877	41.9	2,691	21.8	57,358	11,155	42,249
1971	39,491	98.0	25,046	30.7	3,390	57.5	943	9,795	22.5	4,224	56.7	3,013	23.4	64,047	11,471	42,701
1972	35,198	105.7	27,403	31.5	4,166	54.1	877	9,479	20.7	3,647	67.2	3,265	20.6	57,421	13,984	45,698
1973	37,220	100.0	34,100	30.5	3,300	55.3	908	10,690	23.6	4,050	65.4	4,113	22.1	61,760	11,989	56,416

[1]Includes Iowa, Indiana, Illinois, Ohio, Missouri, and Minnesota.

[2]Includes Mississippi, Louisiana, Arkansas, and Tennessee.

[3]Includes Virginia, North Carolina, South Carolina, Georgia, and Alabama.

Source: Crop Production Report, Statistical Reporting Service, USDA.

METHOD OF ANALYSIS

To measure the ability of soybeans to compete for resources in 1974, iso-returns curves were calculated for soybeans and the primary competing crop in each of the three main soybean-producing regions. These curves can be used to determine the prices of soybeans required to yield returns equal to those of the competing crop at various crop prices.

The analysis is keyed to assist farmers in making planting decisions in the spring. Only variable costs were included in the development of the iso-revenue lines under the assumption that at the time of planting, only marginal shifts could be made in acreage planted.

VARIABLE PRODUCTION COSTS

Production costs have increased significantly in recent years, altering the competitive position of the various crops and changing the relative prices necessary to yield equal returns. Table 2 contains the 1974 estimated costs used in the analysis, as well as estimated costs for 2 previous years. There were significant cost increases between 1970 and 1974, and costs were up for each crop in every region. The largest change was the 50-percent increase for soybeans produced in the South Atlantic region. Different input costs and application rates cause the regional differences in variable cost within a year.

DERIVATION OF PRICE EQUATIONS GIVING EQUAL NET RETURNS

To show the competitive position of soybeans for resources relative to corn and cotton, net returns per acre over a range of prices were calculated for each enterprise using the following equations:

(1) $NR_{SB} = P_{SB} \cdot Y_{SB} - VC_{SB}$

(2) $NR_{C} = P_{C} \cdot Y_{C} - VC_{C}$

(3) $NR_{CT} = P_{CT} \cdot Y_{CT} + P_{CTS} \cdot Y_{CTS} - VC_{CT}$

where:

NR_{SB}, NR_{C}, NR_{CT} = Net returns per acre for soybeans, corn, and cotton, respectively.

P_{SB}, P_{C}, P_{CT}, P_{CTS} = Prices per bushel for soybeans and corn, price per pound for cotton lint, and price per ton for cottonseed, respectively.

Y_{SB}, Y_{C}, Y_{CT}, Y_{CTS} = Yields per acre for soybeans, corn, cotton lint, and cottonseed, respectively.

VC_{SB}, VC_{C}, VC_{CT} = Variable costs per acre for soybeans, corn, and cotton, respectively.

Table 2--Variable costs per acre for soybeans, corn, and cotton, selected regions, 1970, 1973, and 1974[1]

Region and crop	Variable costs per acre[2]			Percent change, 1970 to 1974
	1970	1973	1974	
	--Dollars--			Percent
Corn Belt:				
Corn	47.66	57.19	69.58	+46
Soybeans	22.93	30.79	32.23	+41
South Atlantic:				
Corn	37.81	45.75	56.38	+49
Soybeans	27.60	36.43	41.32	+50
Delta:				
Cotton	129.23	149.47	174.88	+35
Soybeans	23.45	32.09	33.57	+43

[1]Unpublished cost estimates made by Herbert Brown, ERS, CED, in January 1973. Since that time costs have increased primarily because of higher fertilizer and fuel costs. These changes will cause a larger increase in production costs for corn than for soybeans. Thus, to evaluate the competitive advantage for the spring of 1975, costs per acre will need to be adjusted.

[2]Includes a charge for operator and family labor at hired labor wage rates.

The iso-returns curve between soybeans and its resource competitor in each of the regions was calculated from the net returns equations above. To solve any two of these equations for prices giving equal net returns per acre, the equations must be set equal to each other. For example, to compute break-even prices for corn and soybeans, equations (1) and (2) are used, that is,

$$(4)\quad NR_{SB} = NR_{C}$$

or

$$(5)\quad P_{SB} \cdot Y_{SB} - VC_{SB} = P_{C} \cdot Y_{C} - VC_{C}.$$

Solving for P_{SB}:

$$(6)\quad P_{SB} = \frac{(P_{C} \cdot Y_{C} - VC_{C} + VC_{SB})}{Y_{SB}}$$

From this equation, break-even soybean prices for any level of corn prices can be obtained given costs and yields. As stated, projected 1974 costs and 1973 yields for the three regions were used. This approach, however, can be individualized and any producer can substitute his own price, cost, and yield components into the equation.

An equation similar to (6) is derived for break-even cotton/soybean price comparisons:

$$(7)\quad P_{SB} = \frac{(P_{CT} \cdot Y_{CT} + P_{CTS} \cdot Y_{CTS} - VC_{CT} + VC_{SB})}{Y_{SB}}$$

Several factors were not considered in the analysis. For example, economies of scale might exist for producers with large acreage. In addition, at higher output prices, some shifts may occur in the intensity of input use, thus altering average costs. The costs and yields used represent regional averages with the costs not including the fixed portion. If these are not consistent with those of a particular farmer, he can calculate individual graphs based on equations (6) and (7) using his own expected costs and yields.

REGIONAL RESULTS

Equations (6) and (7), along with the yield and cost data presented in tables 1 and 2, respectively, were used to compute the break-even prices yielding equal net returns presented in figures 1, 3, and 5. The regional results which follow have implications for producers making planting decisions and for policymakers in terms of analyzing expected shifts among major competing commodities.

By inserting the data from tables 1 and 2 into equation (6), the following break-even price relationship between soybeans and corn was obtained:

$$P_{SB} = \frac{P_C \cdot 100.0 - 69.58 + 32.23}{30.2}$$

For example, at a corn price of $2.75 per bushel, the break-even soybean price is $7.87 per bushel. Figure 1 plots the set of soybean and corn prices yielding equal returns. Thus, any combination of price expectations can be immediately analyzed to determine which crop alternative would be expected to yield the greatest return.

During the spring of 1974, when final planting decisions were being made, corn prices in the Corn Belt region averaged $2.62 per bushel. At this price, the soybean price yielding equal returns is $7.60 per bushel. However, the average price of soybeans received by farmers in the Corn Belt during January and February of 1974 was only $5.96, or $1.64 per bushel below that required to break even with corn. During this period, December 1974 corn futures prices, at which producers could have hedged, range from $2.52 to $3.20. November 1974 soybean futures prices averaged $6.25 per bushel.

Figure 1

The planting intentions published in the March Crop Report reflected the relative disadvantage of producing soybeans. Corn Belt farmers indicated that 4.7 million more acres of corn would be planted than in 1973 and that 1.8 million fewer soybean acres would be planted.

At the time farmers were indicating these intentions the price ratio was 2.23:1. However, this analysis indicates that the required break-even price ratio was 2.85:1. Closer inspection indicates that the price ratio for break-even returns is not constant and varies as the price, costs, and yield vary. Figure 2 plots the break-even soybean/corn price ratio at various corn prices. At the yields and costs indicated, the ratio varies as the price levels change. The ratio increases rapidly between corn prices of $1.00 and $2.00 per bushel. Above $2.00 per bushel for corn, the rate of increase of the break-even soybean/corn price ratio slows considerably and asymptotically approaches the ratio of soybean and corn yields as a maximum. With yields of 100 bushels per acre for corn and 30.4 bushels for soybeans in the Corn Belt, the asymptotic maximum break-even price ratio is 3.31:1. As yields and costs change the entire function will shift, yielding different ratios.

Actual returns depend on harvest prices, thus an imbalance between returns to corn and soybeans should not be a signal for a massive shift in acreage from, say, soybeans to corn. Such a shift would drive soybean prices up and corn prices down, altering the harvest prices and the returns per acre. However, individual farmers could hedge or contract at planting time to remove most of the price uncertainty.

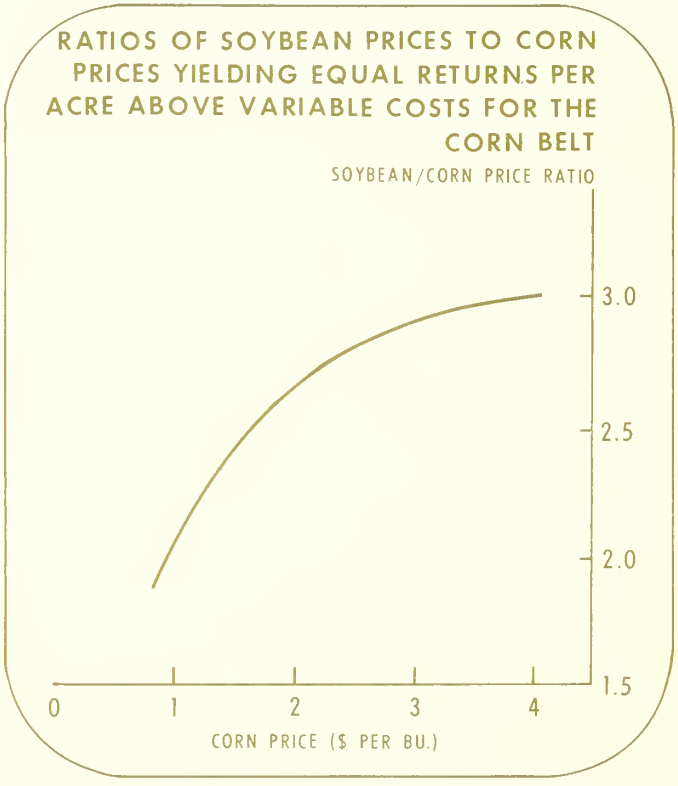

Figure 2

South Atlantic

Using equation (6) and the data in tables 1 and 2, the following equation was developed to calculate the break-even price relationship between corn and soybeans for the South Atlantic region:

$$(8)\quad P_{SB} = \frac{P_C \cdot 65.4 - 56.38 + 41.32}{22.1}$$

Corn prices in the South Atlantic during January and February averaged $2.85 per bushel. Using equation (8), the break-even price for soybeans is $7.75 per bushel. However, at the time, soybeans in the region were averaging $6.04 per bushel or $1.71 below break-even. Hedging and contracting alternatives reflected similar differences. This imbalance was reflected in the March planting intentions. At that time, farmers in the region indicated that they planned to plant 472,000 more acres to corn and 300,000 more to soybeans. However, the increase in soybean acreage was the smallest since 1969, and the increase in corn the largest since then.

Figure 3 shows the set of prices representing equal returns between corn and soybeans for the South Atlantic region. The break-even soybean/corn price ratio is plotted as the dotted line in figure 4, where it is compared with the Corn Belt curve. For example, at a corn price of $1.00 per bushel the break-even soybean/corn price ratio is 2.28:1. The price ratio for the South Atlantic region also increases rapidly between corn prices of $1.00 and $2.00 per

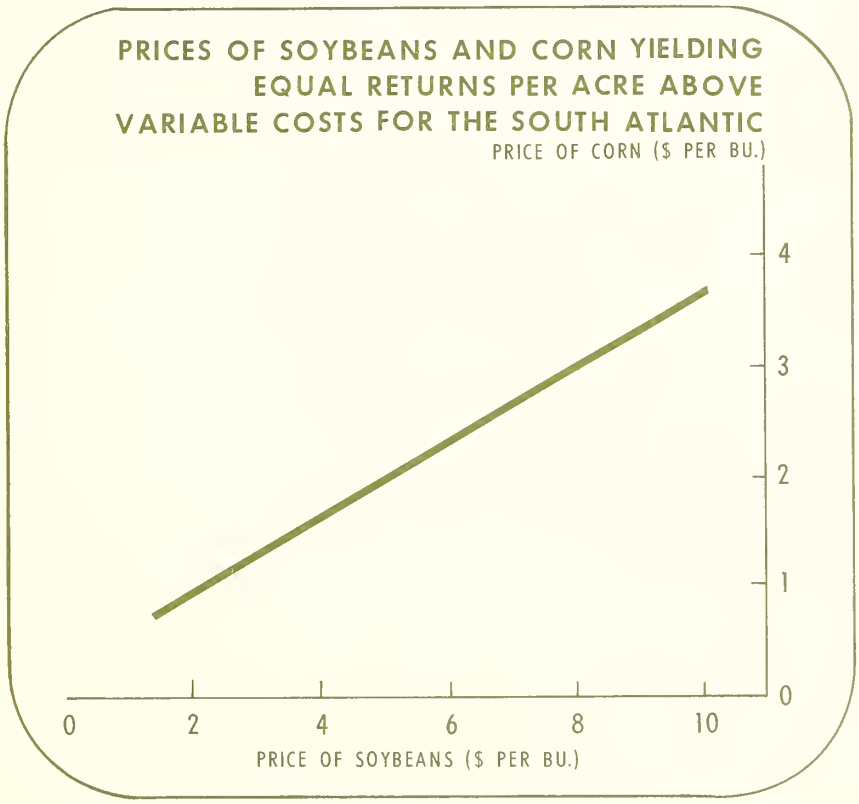

Figure 3

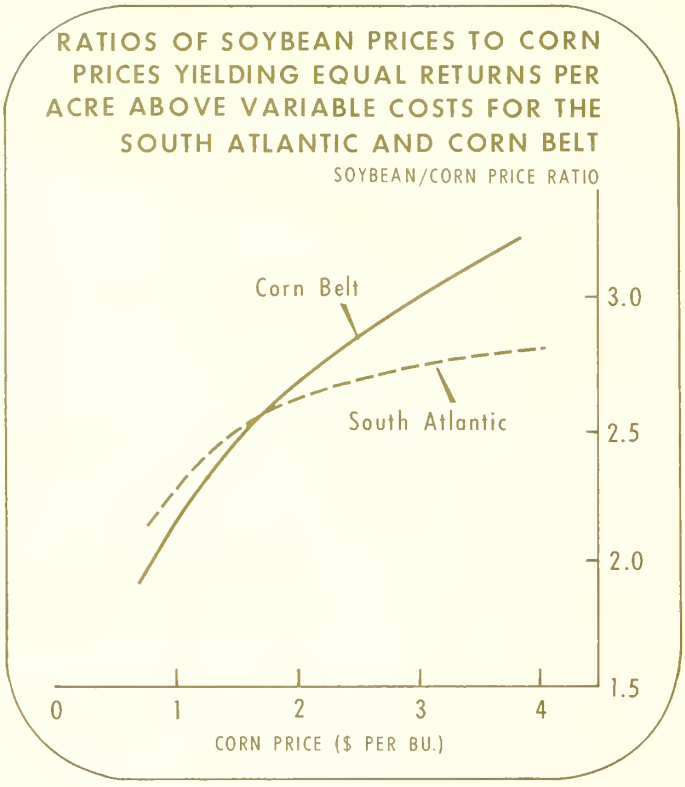

Figure 4

bushel. However, with corn and soybean yield averaging 65.4 and 22.1 bushels per acre, respectively, the function asymptotically approaches a ratio of 2.96:1 which is lower than that for the Corn Belt. A comparison of the two curves shows that at lower price levels, soybeans are more competitive with corn in the Corn Belt than in the South Atlantic. However, at higher price levels (above $1.60 for corn and an equivalent soybean price), soybeans are more competitive with corn in the South Atlantic than in the Corn Belt. Thus, the difference in intended acreage shifts between the two regions is not surprising.

Delta

Inserting the data from tables 1 and 2, the following break-even price relationship between soybeans and cotton in the Delta region was obtained:

$$(9)\quad P_{SB} = \frac{P_{CT} \cdot 553 + P_{CS} \cdot 0.453 - 174.88 + 33.57}{23.6}$$

Cotton prices in the Delta during January and February 1974 averaged $0.53 per pound for lint and $97.00 per ton for cottonseed. Using equation (9), the break-even price for soybeans at these cotton and cottonseed prices was $8.29 per bushel. During these same 2 months, farmers in the Delta were averaging only $5.98 per bushel for soybeans, $2.31 below the break-even price. Hedging and contracting alternatives showed similar differences. Figure 5 plots the set of cotton and soybean prices yielding equal net returns. The line plotted

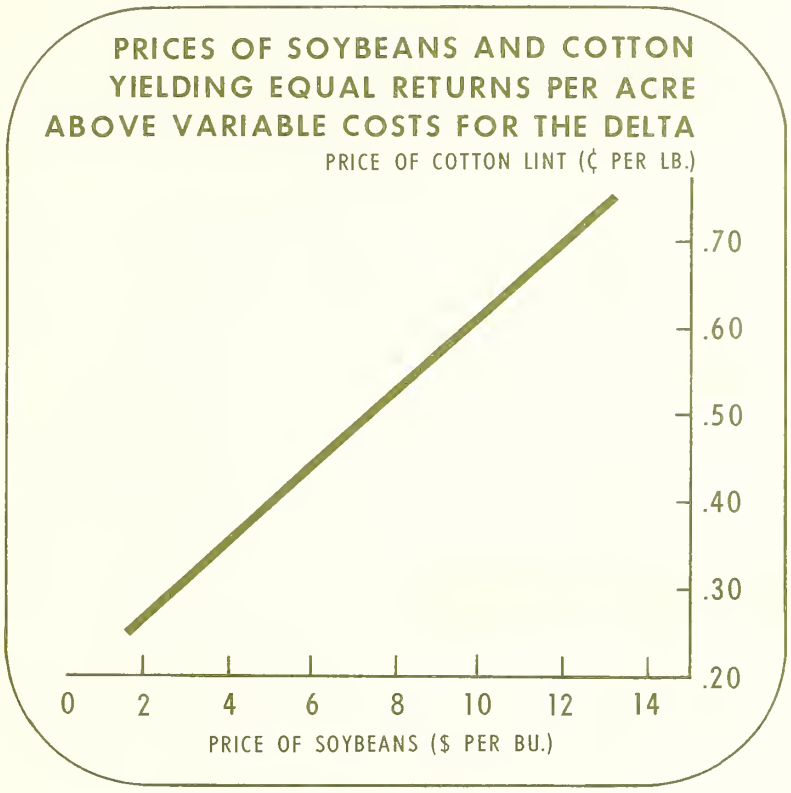

Figure 5

represents break-even prices between cotton and soybeans at various lint prices with cottonseed price held constant at $97.00 per ton. A change in the price of cottonseed will shift this line up or down, causing a change in the set of prices yielding equal returns.

At planting time in 1974, market prices for cotton exceeded support prices in the absence of marketing quotas for the first time since 1953. Farmers had to decide whether to plant acreage to cotton in addition to the land traditionally planted under the allotment and marketing quota programs. Since the two major crop alternatives in the area were cotton and soybeans, and since soybeans were selling at more than $2.00 below the break-even price, farmers decided to plant more acreage to cotton and less to soybeans. March intentions indicated that farmers in the Delta region planned to plant 4,495,000 acres of cotton and 10,560,000 acres of soybeans, an increase of over 1 million acres of cotton and a decrease of 37,000 acres of soybeans, compared with a year earlier. These changes reflect both the imbalance between the anticipated returns to cotton and soybeans and the change in the 1974 cotton program.